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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/941,612	08/30/2001	Yoshinobu Aoyagi	1794-0141P	6758

2292 7590 01/02/2004

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 01/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/941,612	AOYAGI ET AL.	
	Examiner	Art Unit	
	Matthew J Song	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *25 August 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *4-21 and 26-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *4-21 and 26-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8/25/2003 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 4-21 and 26-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554).

Nishizawa et al discloses a method of growing doped semiconductor monolayers, note entire reference, comprising raw material gases of Gallium (Ga) and Arsenic (As), where Ga is supplied for 0.5 to 10 seconds, the chamber is evacuated, this reads on applicant's purged for a predetermined time, and As is supplied for 2 to 200 seconds and the cycle is repeated (col 7, ln 1-67; col 8, ln 1-30 and Fig 7B and Fig 11). Nishizawa et al also discloses a p-type layer is formed by introducing an impurity gases and Ga simultaneously but alternately with an As source, where the impurity gas is an Mg, Zn or Cd containing gas or Silane. Nishizawa et al also discloses a n-type layer doped with Se or S and the impurity gas is introduced cyclically with the Ga gas and As gas or the impurity gas and Ga gas are introduced simultaneously but alternately with the As gas (col 8, ln 31-60). Nishizawa et al also discloses forming pnp bipolar transistors (col 8, ln 61-67). Nishizawa et al also discloses nozzles 44, 45 and 46 for introducing gaseous compounds used for impurity doping for introducing group II, IV and VI gases (col 10, ln 50-67). Nishizawa et al also discloses different modes of doping, where the dopant is added at the exhaustion of an As gas, the introduction of a Ga gas, the exhaustion of a Ga gas or at the introduction of As gas (col 11-13 and Fig 11). Nishizawa et al also discloses other III-V semiconductors are applicable to the invention (col 14, ln 5-55). Nishizawa et al also discloses introduction of a Ga source gas and a group II dopant simultaneously to form a p-type layer (col 8, ln 30-45) and the introduction of a group IV dopant after the introduction of a Ga source gas (col 15, ln 5-50). Nishizawa et al also discloses selection of the timing of doping with respect of

the source gas introduction is based on the desired dopant type for the monolayer being grown (col 15, ln 45-55).

Nishizawa et al does not disclose the given time for supplying each of the impurity raw materials are close to each other.

Edmond et al teaches a gallium nitride (GaN) layer co-doped with both a Group II acceptor and Group IV donor (col 4, ln 50-67), where the group II acceptors include Zn or Mg and the Group IV donors include Si or Ge (col 6, ln 20-50), this reads on applicant's the time for supplying each of the impurity raw materials are close to each other. Edmond et al also discloses the GaN layer is formed by CVD, where Trimethylgallium (TMG), ammonia, silane and biscyclopentadienyl magnesium, $(Cp)_2Mg$ are used as reactant gases (col 7, ln 45-67 and col 8, ln 1-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nishizawa et al with Edmond et al to form a co-doped GaN layer useful as an active layer (Abstract).

The combination of Nishizawa et al and Edmond et al is silent to forming impurity pairs within at least one of the crystal raw materials. The combination of Nishizawa et al and Edmond et al teach supplying similar raw materials and impurities, as applicant. Also, the combination of Nishizawa et al and Edmond et al teach a similar method of supplying raw materials, purging and supplying impurities, as applicant. Therefore, the plural types of impurity raw forming impurity pairs within at least one of the crystal raw materials is inherent to the invention taught by the combination of Nishizawa et al and Edmond et al. The inherent forming of impurity pairs using co-deposition is evidenced by Pankove (US 4,028,720) and Anayama et al (US 5,799,027), below.

The combination of Nishizawa et al and Edmond et al is silent to causing a decrease in activation energy and an increase in carrier concentration. The combination of Nishizawa et al and Edmond et al inherently teach forming impurity pairs of similar raw materials and impurities, as applicant, therefore a decrease in activation energy and an increase in a carrier concentration is inherent because impurity pairs are formed. The formation of similar impurity pairs will be expected to have the same results of decreasing the activation energy and increasing carrier concentration. Furthermore, Applicant has admitted that the activation energy is decreased and the carrier concentration is increased as a result of forming impurities pair, note page 19, lines 11-17 of the reply filed on 8/25/2003, which provides evidence of the decrease in activation energy and increase in carrier concentration is inherent when impurity pairs are formed.

Referring to claim 4, the combination of Nishizawa et al and Edmond et al teaches forming a co-doped GaN layer using Mg and Si dopant, where the compound semiconductor layer is grown in monolayer by alternate introduction of source gases and the chamber being evacuated continuously throughout the whole method ('139 col 3, ln 35-45) and the Si is introduced after the Ga source gas to act as a donor and a Ga source and a Mg dopant are introduced simultaneously but alternately with a As source.

Referring to claim 5, the combination of Nishizawa et al and Edmond et al teaches the introduction of a group IV dopant after the introduction of Ga and prior to the introduction of As and the introduction of group II dopant after the introduction of Ga and prior to the introduction of As (col 13, ln 10-35 and Fig 11).

Referring to claim 6-10, the combination of Nishizawa et al and Edmond et al teaches Ga as a first raw material gas and As or N as a second raw material gas.

Referring to claim 11-20, the combination of Nishizawa et al and Edmond et al teaches a co-doped layer with p-type and n-type impurities.

Referring to claim 21, the combination of Nishizawa et al and Edmond et al teaches using a silane dopant gas. The combination of Nishizawa et al and Edmond et al does not teach using a TESi dopant gas. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al by substituting TESi gas for silane because TESi is an equivalent Si source for doping and substituting equivalents for the same purpose is obvious (MPEP 2144.06).

4. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554) as applied to claims 4-21 and 26-28 above, and further in view of Manabe et al (US 6,472,690).

The combination of Nishizawa et al and Edmond et al teaches all of the limitations of claim 21, as discussed previously, including using silane as a Si dopant. The combination of Nishizawa et al and Edmond et al does not teach supplying TESi

In a method of forming a gallium nitride compound semiconductor, note entire reference, Manabe et al teaches forming an n^+ type Gallium nitride layer, using silane or tetraethylsilane (TESi) (Example 4). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al with

Manabe et al because substituting known equivalents for the same purpose is obvious (MPEP 2144.06).

Response to Arguments

5. Applicant's arguments with respect to claims 4-21 and 26-28 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments filed 8/25/2003 have been fully considered but they are not persuasive.

Applicant's arguments the combination of Nishizawa et al and Edmond et al are noted but are not found persuasive. Applicant alleges that the combination of Nishizawa et al and Edmond et al does not teach the lowering of activation energy or the increase in carrier concentration. The Examiner has admitted this in the new grounds of rejection, however this limitation would be inherent to the combination of Nishizawa et al and Edmond et al, as discussed previously. The Examiner maintains that the formation of impurity pairs is inherent to the combination of Nishizawa et al and Edmond et al because the combination of Nishizawa et al and Edmond et al teaches co-deposition of impurities, which will form impurity pairs, as evidenced by Pankove (US 4,028,720) and Anayama (US 5,799,027) below. Applicant has admitted that the activation energy is decreased and the carrier concentration is increased as a result of forming impurities pair, note page 19, lines 11-17 of the reply filed on 8/25/2003, which provides evidence of the decrease in activation energy and increase in carrier concentration is inherent when impurity pairs are formed.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., the hole concentration in the range of 10^{19} on page 17) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Pankove (US 4,028,720) teaches gallium and arsenic, as impurities are co-deposited together with silicon on a wafer to form molecular impurity pairs (col 3, ln 30-45 and col 4, ln 1-5).

Anayama et al (US 5,799,027) teaches pairing probabilities of p and n type impurities can be lowered with the crystal plane used when impurities are doped at the same time (col 18, ln 55-67).

Daly (US 5,231,298) teaches co-doping GaAs and co-doping improves the performance of the resultant device, effects alloy hardening, inhibits defect formation, improves mobility and reduces the energy gap (col 3, ln 1-20).

Goetz et al (US 6,441,393) teaches a nitride layer is co-doped using co-dopants of Si/Ge, Si/Sn an Ge/Sn to stabilize the structural integrity of the a III-V nitride on a lattice mismatched substrate (col 5, ln 45-65).

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS

ROBERT KUNEMUND
PRIMARY EXAMINER